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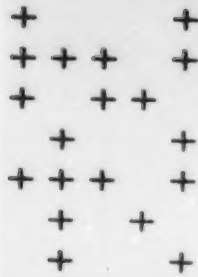
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Les centres de recherche de Pêches et Océans :
Exemples de transfert technologique

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Benefits for Canadians



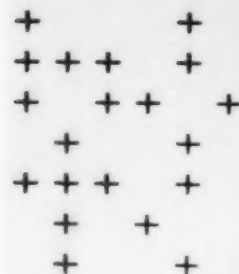
Fisheries and Oceans
Research Centres

Cases of
Technology Transfer

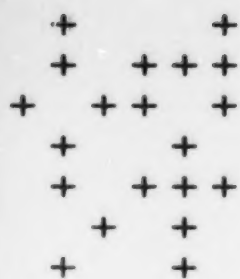
Economic and
Commercial Analysis
Directorate
in Cooperation
with the Science Sector



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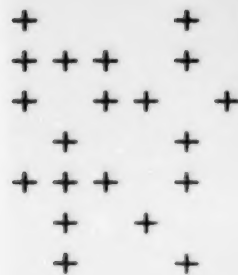
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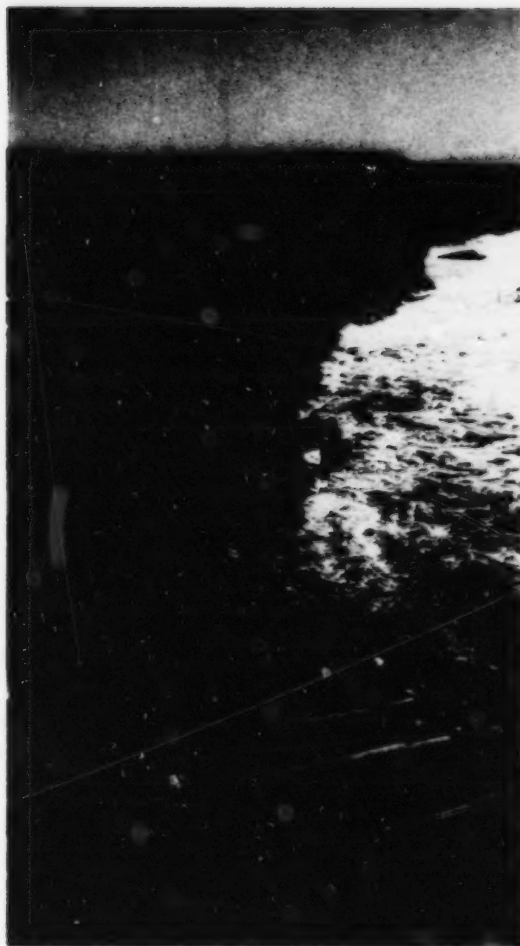
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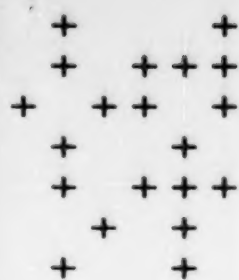
Preface



These studies of technology transfer provide a concrete supplement to the companion report, "Fisheries and Oceans Research Centres: Economic and Technological Benefits". They are a small sample of the many specific instances where departmental activities have encouraged technology adoption by the private sector.

Research centres provide incubation for technology. Highly skilled labour clusters at that location. Risk capital may be more accessible since local financial institutions begin to appreciate the S&T milieu and become more receptive to capital financing proposals. Ideas are exchanged and technology transferred. New firms are born to exploit the spinoffs, and many of these firms are supported during critical periods by contracts, expertise, and access to centre facilities.





1. The Seakem Group of Companies

*T. Curran**

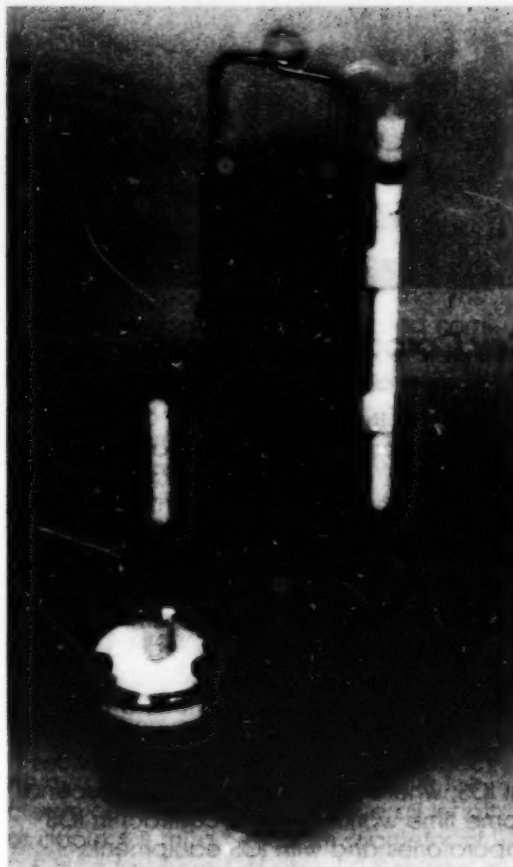
Introduction

One of the first companies to come into existence because of the formation of the Institute of Ocean Sciences (IOS) at Patricia Bay, B.C., was Seakem Oceanography Limited. It was formed in 1974, when three recent graduate students working as DFO employees with DFO's Ocean Chemistry group recognized a potential entrepreneurial opportunity. At that time, the Make-or-Buy policy was coming into force, and there was strong encouragement to contract out science and technology, and consequently develop private sector expertise.

The Seakem Group

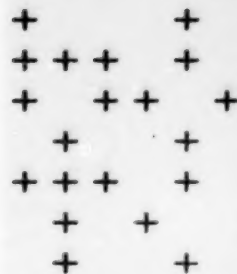
Seakem has flourished, and now consists of seven related companies. Seakem Oceanography remains the main consulting company, with expertise primarily in chemistry and physics. Seastar Instruments is the manufacturing arm, formed in 1984; it has specialized in fibre optics, acoustics, and general scientific instrumentation. Seastar Chemicals Inc. is a 1986 addition to the group, when it became apparent that the high-purity acid technology within Seakem presented a market opportunity. Arctic Laboratories is a currently inactive company in Inuvik, N.W.T., awaiting a resurgence in oil exploration. Additionally, there are two companies in Dartmouth, N.S.: they are Seakem Oceanography Limited and Seastar Instruments Limited, which perform the same functions on the east coast as their namesakes on the west coast. There is a small sales company in Seattle, Washington, to facilitate access to the United States market.

The group is controlled by four directors, and is privately held.



Corporate Status

The staff of the group of companies is constantly growing, and presently totals about 15 professionals and 50 support personnel. Gross annual sales are approximately \$5 million, of which \$2 million involve federal participation and the remainder comes from sales to Crown corporations, other foreign government agencies, and private companies.





Key Corporate Transitions

In 1977, three years after the formation of Seakem, the new Institute of Ocean Sciences was ready for occupancy in Patricia Bay, and Seakem relocated there to remain near its primary clients. Between 1977 and 1980 the firm received a continuing series of competitive contracts.

In 1980, the company purchased land and erected a building within a few minutes drive from IOS. They regard proximity to IOS as essential, because IOS has capital-intensive test equipment, a free library, and access to smart people.

Seakem still wins contracts for services at IOS, where there is a necessity to spend some time working under contract in IOS laboratories and with IOS equipment. Within reason, this is viewed as healthy and exposes the company to techniques and ideas. A similar relationship is maintained at BIO, for the same reasons.

Since 1983, Seakem has been diversifying into manufacturing and non-oceanographic areas in order to exploit niche markets.

As of 1987, Seakem has a geographically and technically diverse empire. It has operations in two provinces, the Northwest Territories, and the United States, and has three major buildings in Sidney. Sales, profits, and personnel are all increasing.

General Comments

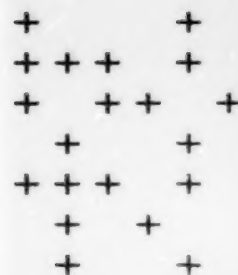
The IOS-Seakem success story is a little unusual, but not unique. It is more a comment upon an openness to industry on the part of IOS and of the superstars at Seakem, who continue to triumph over many petty obstacles and thrive. Seakem would fail if its principals ever lost the desire to succeed.

A fundamental factor in every corporate success story is access to funding. Seakem acknowledges that the Unsolicited Proposal (UP) program is without doubt a very key factor in its success. The progressive attitude of successive directors has minimized the paperwork, and maximized the accessibility of the program. The cost-sharing arrangement with IOS has helped both parties involved while expertise was transferred to the private sector.

**Mr. Curran is Senior Industrial Liaison Officer, Institute of Ocean Studies, DFO, Patricia Bay, British Columbia.*

2. FGGE Drifting Buoys

*J. Garrett**



Background

The first system for tracking mobile transmitters was placed on an orbiting satellite in the mid-1960s. The demonstration of the potential of such systems led to their rapid evolution, with each successive generation achieving significant reductions in the cost and power of the transmitters being tracked. The author became involved in the development of satellite-tracked drifting buoys as early as 1971. By 1973, it was clear that relatively inexpensive drifting buoys could be used to gather simple surface meteorological data from areas of the ocean where other data was inadequate to describe weather systems. An array of such buoys covering the southern oceans was therefore included as an essential element in the plans for the First GARP (Global Atmospheric Research Program) Global Experiment (FGGE). This was a major international effort to obtain the first global meteorological data set suitable for testing atmospheric models; it took place between December 1978 and December 1979. The then Director-General of IOS, Dr. R.W. Stewart, who was involved in the planning for FGGE, suggested that Canada could make a significant contribution to this experiment.

Joint Projects

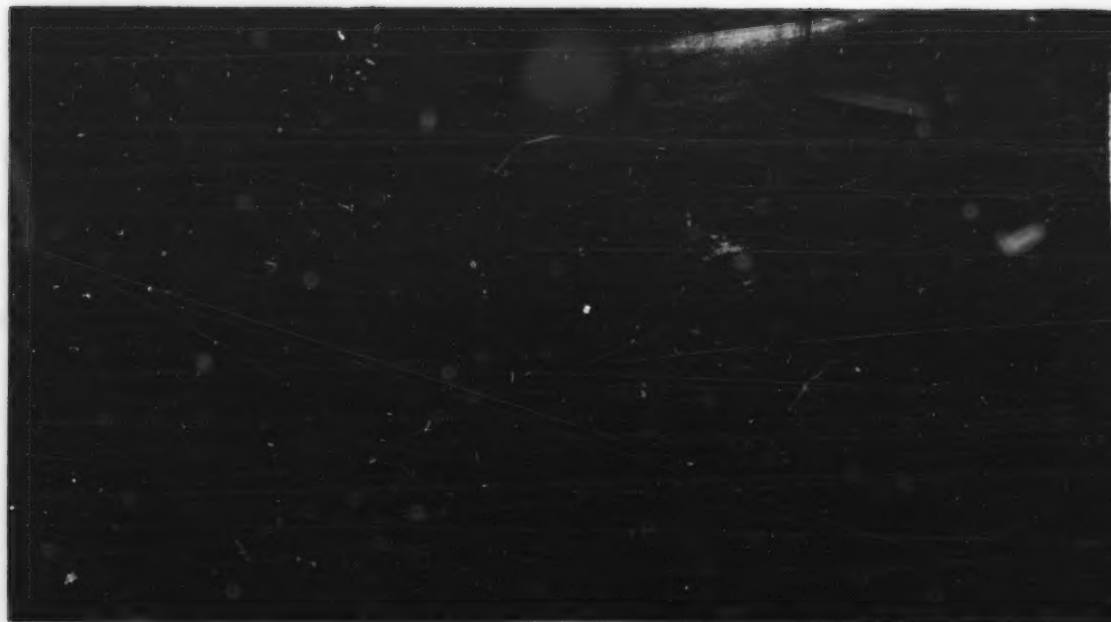
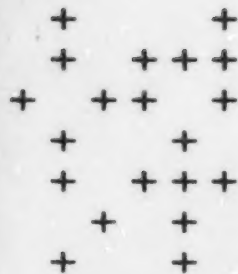
This idea was accepted by both the Atmospheric Environment Service (AES) and the Ocean and Aquatic Sciences Branch (OASB) of Environment Canada. The development of a suitable buoy was included in a large project called the Canadian Ocean Data System (CODS), initiated in May 1975 as a UP by Hermes Electronics Ltd., of Dartmouth, Nova Scotia. Hermes Electronics is a large company that mainly supplied sonobuoys to military markets, and wished to diversify into a less cyclic area. The overall project also

included construction and testing of several types and sizes of moored buoys.

Initial development included the construction of 20 drifting buoys and their deployment in the Southern Hemisphere to demonstrate that the required reliability could be achieved. Canada was one of the first countries to announce a commitment to the "Southern Hemisphere Drifting Buoy System," and early Canadian testing helped convince other countries that the system was possible. This stimulated commitments of other types, and is considered to have materially contributed to the success of the FGGE.

Apart from obvious concerns such as transmitter and battery reliability, the most critical problem was meeting the very stringent accuracy and stability requirements for the barometric pressure measurement while keeping out water in heavy breaking waves. The final design was a collaborative effort, drawing on government scientists' expertise in specific measurement systems and company engineers' expertise in fabrication and the achievement of quality control in production. The resulting Hermes FGGE buoy was a distinctive ice-cream-cone shape, with an overall length of about 1.8 m, a maximum diameter of 0.6 m, a freeboard of about 0.8 m and a total weight of about 100 kg. It could be launched from a ship under way using a simple 'burial at sea' technique. The reliability demonstrated by the 20 prototypes was such that 70 per cent were still working after a year, which was the design battery life.

The success of the prototypes cleared the way for an order for 80 buoys for the FGGE experiment itself, at a total cost of approximately \$400,000. The satellite, and therefore the buoy transmitters, were to be different from those tested on the prototype. In order to have the buoys in place for launching, the first deliveries were



required by March 1978, while the satellite launch was not expected before June 1978 (and actually occurred in October 1978). Thorough laboratory testing of the new transmitters was therefore the only way to achieve the required reliability.

Hermes expertise in production quality control resulted in quick recognition and resolution of quality problems on the part of the manufacturer of the pressure transducer, which was also used by other countries' buoys.

The 80 Canadian buoys were part of an international total of 368. The overall buoy array was extremely successful, providing good data throughout the experiment. Several studies indicated that weather forecasts in several Southern Hemisphere countries were immediately improved. However, this did not result in a large immediate post-FGGE market for buoys, as most countries had obtained special one-time funding for the FGGE, and the recessionary period of the early 1980s was not a good time for meteorological services to be looking for additional long-term resources.

The CODS project, including drifting buoy development, continued in a variety of forms for a few years after the FGGE. Subsequent joint developments included a

satellite-tracked ice-beacon which could be air-dropped onto the ice, and a low-drag air-droppable drifting buoy.

Consequences

In the nine years since the FGGE, Hermes has delivered a further 475 drifting buoys, representing between 15 and 20 per cent of the total global sales of such buoys. Customers other than the Canadian government purchased 290, of which 90 were exported. The present price for a simple drifting buoy is about \$7,000, but optional sensors can increase this significantly.

The buoy transmitter was originally purchased from another supplier, but Hermes eventually developed its own, and has delivered about 400 of these, usually in completed buoys. Approximately 100 were sold separately, mostly to export markets.

Engineering staff associated with Hermes drifting buoy developments now form the nucleus of two other successful companies: Focal Marine and MetOcean Data Systems Ltd. The latter is of particular note, as one of its main product lines is an advanced drifting buoy, designed to be deployed through the sonobuoy chute on military patrol aircraft.

**Dr. Garrett is Head of Ocean Physics, Institute of Ocean Sciences, DFO, Patricia Bay, British Columbia.*

3. The SEIMAC Group of Companies

D.L. McKeown*

Introduction

The Role of PCSB Scotia-Fundy in Technology Spin-off

DFO's Physical and Chemical Sciences Branch (PCSB) Scotia-Fundy conducts scientific investigations related to oceanography. In the course of its work, scientists and engineers sometimes require specialized instruments or measuring technology. Usually such products are sufficiently unique, complex to build or difficult to maintain that they have no commercial value. However, in some cases, either the device or technology is marketable in its own right, or the experience to be gained by being involved in its evolution would be of benefit to the private sector. In such cases, financial resources permitting, the research work is done under contract.

The Seimac Group of Companies

The Seimac group consists of: Seimac Ltd., formed in 1978 and specializing in microelectronics and instrumentation; Focal Marine Ltd., formed in 1983 and specializing in electro-optical technology; and Oceanroutes Canada, created in 1983 to encompass the meteorological and oceanographic science interests of the group. They began life with two full and two part-time employees. In nine years, this has grown to 36 full-time staff members. PCSB involvement with the Seimac group began in 1983, has increased dramatically and will continue to do so.

Chronological Sequence

The Early Days

In 1981, DFO's Marine Fish Division (MFD), which had been given funding to contract for engineering support in lieu of technical staff, hired Seimac via a competitive bid to maintain and repair oceanographic equipment and to develop various electronic interfaces for instruments and equipment employed in MFD programs. This provided Seimac with a vital opportunity to demonstrate its capabilities and become known at BIO.

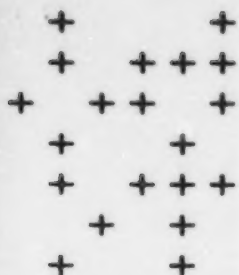
The Data Highway

During this period, Seimac was acting as a subcontractor to Ferguson Industries of Pictou, N.S., which was building the two new DFO research vessels, the *Alfred Needler* and the *Wilfred Templeman*. While working on this project, Seimac conceived the idea of a data network or "Data Highway" to link the disparate electronic research equipment such as the fish-finding sonars and navigation equipment in order to simplify scientific data logging. The firm's UP for \$250,000 was accepted, and the first system was installed on the *Templeman*. On the *Needler*, DFO chose to duplicate an earlier Seimac system used so successfully on the *Lady Hammond*. Since that time the *RV Gadus Atlanticus* has been acquired in anticipation of installing a Data Highway.

Oceanographic Instruments Facility

By 1983, PCSB was seeking a contractor to acquire its oceanographic instrument calibration and maintenance technology in order to meet the anticipated





workload from its expanding Office of Energy Research and Development (OERD) programs. An agreement was reached with Seimac to transfer the technology to the firm through a cost-shared Program for Industry/Laboratory Projects (PILP) contract. Seimac placed two staff members within PCSB laboratories to work side-by-side with Institute staff. In addition to transferring the technology, the arrangement allows the company to make valuable contacts. Towards the end of the program, the company took on some commercial contracts. Eventually, Seimac rented separate space on the BIO campus and acquired its own calibration and maintenance equipment. There continues to be a close collaborative relationship between the company and the laboratory in this endeavour. Seimac has also become an official Guildline Instruments and General Oceanics service depot and acts as a subcontractor to them for special Conductivity-Temperature-Depth (CTD)-related electronic designs and modifications.

Oceanographic Data Buoys

In 1985, the company submitted a \$465,000 UP to develop instruments and support systems for near real-time monitoring of Arctic oceanic and atmospheric conditions. The AIMS (Arctic Ice Measuring System) project is totally funded through OERD and is due for completion June 1988. During contract negotiations, it was agreed that the company lacked the requisite mechanical engineering expertise. This has been acquired through the cost-sharing Industrial Research Assistance Program (IRAP), which placed a mechanical engineer in the PCSB laboratory for one year under the tutelage of a senior mechanical oceanographic engineer. While the IRAP arrangement has ended, the engineer still works at PCSB two days per week. Major work on the project commenced in early 1986 with a literature search, a study of available sensors and component parts and a user need survey. Three prototypes have been built and tested. The most recent trial off Resolute saw the buoy survive ice break-up and continue to transmit data while it travelled through the eastern Arctic for several hundred miles.

One of the earliest PCSB OERD projects was the development of "Fish Barrel Drifters." These were intended to be low-cost oil spill markers. The initial research was done under contract by MacLaren-Plansearch and resulted in a good understanding of how the hull form behaved. In 1984, Seimac submitted a \$264,000 UP to develop a commercial variant, the Accurate Surface Tracker (AST), with on-board sensors and telemetry and tracking via satellite. Prototypes were built in time for the Canadian Atlantic Storm Project. Subsequently, they were modified to add sensors and ten more were constructed. The project is now complete.

Optical Biological Instruments

In 1984, a PCSB scientist suggested that a remote head could be developed as an "add-on" to a Turner Fluorometer. In 1985, Focal submitted a UP for \$100,000 to explore the feasibility of the idea. Units were developed and tested locally and in the Arctic. While it proved the concept, this prototype has proved too fragile for operational use. The company is now seeking further funding to commercialize the device.

In 1986, Focal submitted a second UP for \$221,000 to develop a state-of-the-art irradiance meter. Scientists at BIO required it to study the physics of light at the snow/ice boundary in the Arctic and to investigate the ways in which light controls biological production in the upper layers of the ocean. DFO labs in Quebec and at Patricia Bay also financially supported the proposal. The instrument is slated for completion in October 1988.

Oceanographic Data Base

In 1986, Oceanroutes began developing a specialized oceanographic data base intended to be of special interest to Canadian and American defence agencies and to oil exploration companies. It will incorporate data sets from BIO, and informal assistance is being provided by Institute staff on request.

Impact on DFO Programs

Oceanographic Instruments Facility

Availability of this facility means that BIO does not have to divert scarce in-house resources to do work for non-PCSB government units. Furthermore, they and private sector contractors can be encouraged to take advantage of its presence to improve the quality of the data they submit to the Marine Environment Data System. For example, requests for instrument calibration from DFO labs in Quebec, St. Andrews, N.B. and Newfoundland have all been redirected to this facility.

Oceanographic Data Buoys

The AIMS program is giving DFO a sensor platform for sea/ice research, data on an intriguing and previously unknown phenomenon of under-ice physics that demands further investigation and a source of private sector R&D Arctic engineering expertise for other programs. Several DFO Arctic research programs are being re-planned to replace simple ice-tracking beacons with more sophisticated units incorporating wind and under-ice sensors.

The 10 enhanced AST buoys have been used by the Centre for Cold Ocean Resources Engineering (C-CORE) to study circulation in Conception Bay, Nfld. They are presently being used to study surface circulation on the Scotian Shelf. Next year, they will be used during a major experiment on Georges Bank. Other experiments are being planned.

Optical Biological Instruments

Focal has proved the feasibility of fitting a remote head to a Turner Fluorometer for ocean profiling and DFO's contribution has been documented in the scientific literature.

This irradiance meter development will provide DFO scientists with the state-of-the-art instrument they require to explore the physics of light in a snow/ice environment and the effects of light on the growth and decay of biological communities in the Arctic and in open water areas.

Future Interactions

It is too early to assess the impact of the Oceanroutes activities on DFO programs, but probably it will be as positive as the examples noted above. It is hoped that Seimac will also extend its activities into the realm of data processing and evaluation as the programs mature. It is not anticipated that the company would compete with established physical oceanographic consulting firms, but would instead be in a better position to evaluate the performance of instruments being developed as well as have an in-house capability to identify end-user needs.

Impact on Seimac Group of Companies

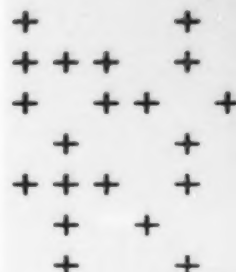
The MFD Connection

The initial MFD contract in 1981 enabled the company to "get its foot in the door." The relative value of the contract has slowly diminished to the point where its main advantage to the company is as a mechanism for maintaining contact with staff at BIO.

The Data Highway, Seimac's first large project, taught the company a great deal about project management. Seimac later developed a fibre optic-based data highway for the CGS *Louis St. Laurent*. Since then, Seimac has acted as consultant on related matters for a number of shipyards and naval architects. Installation of a Data Highway is planned on two new research vessels, and it is in the specification for Canada's Polar 8 icebreaker.

Oceanographic Instruments Facility

The company has acquired expertise that has enabled it to establish a unique operation on the east coast with prospects for substantial market penetration when offshore oil and gas economic conditions improve. In the meantime, Seimac is aggressively marketing the capability and has had some success. Seimac's provision of this service and continued presence on the BIO campus has led to several contractual opportunities, such as an annual maintenance and support contract for the CSS Dawson Ametek Doppler Current Profiler and provision of operators for a





similar system used by EMR in Hudson Bay. PCSB will continue to encourage other government and non-government users of oceanographic equipment to seek calibrations at the Seimac facility in order to improve the quality of the data being submitted to MEDS.

Oceanographic Data Buoys

The literature search, sensor study and user-need study which began this work, gave the company valuable background information for future corporate planning and solicitation of contracts internationally. Quoting J. Seiler of Seimac, the one-year IRAP training period at BIO "gave the company an engineer with a unique depth of understanding of Arctic mechanical design problems and some of their solutions" Seimac's work on this project has led to other government contracts.

The success of the AST developmental work and the resultant interest shown by potential customers has encouraged Seimac to apply to the Canadian Patents and Developments Ltd. (CPDL) for a licence for the technology. It expects to sell variants to the U.S. Coast Guard, the U.S. Environmental Protection Agency (EPA) and AES. With this proven expertise, Seimac will be seeking related R&D work from U.S. and other sources. As a consequence of its involvement in this project the company has acquired an ability not only to do the engineering development, but also to consider the relationship between this and the physical oceanographic characteristics of the device being designed.

Seimac reports that the AIMS and AST projects moved the company into an era of longer-term development projects, caused it to develop more sophisticated project management methods and gave it the expertise necessary to bid on anticipated Department of National Defence (DND) Arctic defence requirements. The projects provided a product line and proven expertise that Seimac plans to market very aggressively to customers such as AES, the U.S. Coast Guard, the U.S. EPA, and oil companies. The company is pursuing sales related to East Greenland and Antarctic research.

Optical Biological Instruments

The Remote Fluorometer Head project provided an early opportunity for Focal to learn how to design and construct underwater optical sensor systems and interface them to fibre optic cables. It also provided the company with a potential commercial product once the design is "hardened." The irradiance meter development will provide Focal with a very competitive product to establish its presence in the marketplace.

Oceanographic Data Base

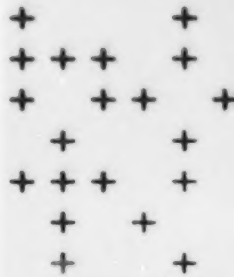
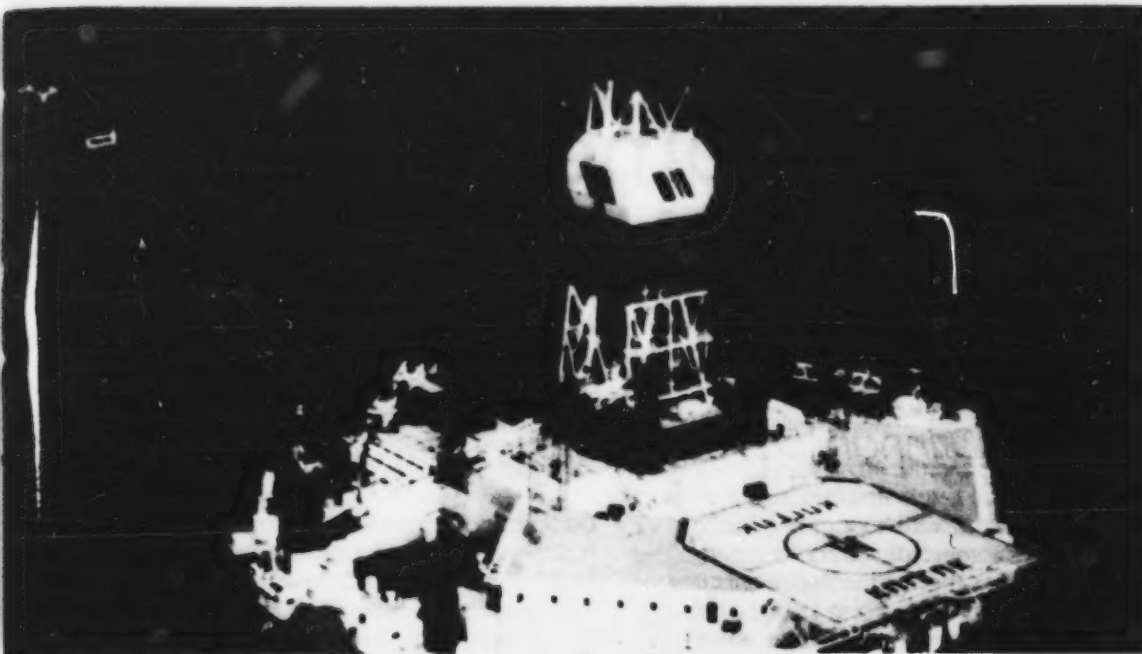
Oceanroutes expects to find a substantial market in DND, the U.S. Navy and the oil industry, and anticipates the development of the data base to generate more R&D contracts.

Related Comments

Seimac notes that the DFO/BIO contracts of 1982 to 1984 were very important in carrying the firm through the recession period and allowing it to emerge in relatively sound financial condition. At present, about 60-70 per cent of the company's business is with the Government of Canada, and the DFO component is an important part of that.

While the above discussion has focused on R&D with the emphasis on the research end of the spectrum, the company has also involved itself with DFO-Scotia Fundy projects that are more strongly oriented to product development. For example, Seimac, in partnership with Eastern Marine Services, has acquired our BIONESE/MININESE technology. Five units, at a system price in excess of \$100,000 each, have been sold overseas, and Seimac has potential orders for three more. This took the company in one major step from a custom "one off" shop to an organization which produces multiple units to a standard design and provides after-sales support to distant customers.

The Seimac group aggressively seek spin-off commercial products or expertise that they can market. They consider DFO at BIO to have a world-class reputation in ocean science and engineering. They use



our collaboration with them as endorsement of their expertise and consider it an important element in marketing company products, especially at establishments such as Scripps Institution of Oceanography, Woods Hole Oceanographic Institute, US Naval Research Laboratories, CSIRO Laboratories in Australia, University of Messina, Italy, etc. At international trade shows, they display equipment developed during such cooperative efforts to attract purchasers and as examples of their activities and capabilities.

Symbiosis

In such a case study, DFO and the company should not be thought of as separate entities. Instead, the ideal situation is a symbiotic relationship where each contributes to the success of the other. In recent years, the goal of both parties has been to develop such a relationship.

The company rents space at BIO and has an engineer assigned to work with DFO staff two days per week. This not only improves communication and collaboration on projects but also reminds us they exist and offers them the opportunity to identify R&D projects where they might exploit or expand their expertise.

An example of the type of symbiotic relationship that is evolving is the joint approach to the upcoming COPEX project of DFO staff at BIO. COPEX is the Coastal Ocean Prediction Experiment, a major oceanographic experiment planned for the early 1990s. It will include a "super mooring" consisting of a cluster of sea-floor instruments, including an RD1 Acoustic Doppler Current Profiler, a WOTANS wind sensor and an Aanderra tide gauge. These will transmit data to surface buoy via cable. The data will then be sent ashore via an ARGOS or GOES satellite link.

In parallel with this and independent of it, Selmac has included in its corporate plan activities designed to exploit its oceanographic buoy expertise. The Institute's COPEX project is an obvious target. Selmac also wishes to commence a program to develop a general-purpose digital signal processor that will reduce the volume of data to be telemetered, logged and processed by pre-processing it within an instrument. Selmac considers significant end-user input to this design an essential part of the engineering development. At present we are discussing how we can marry Selmac's two objectives with ours for COPEX.

*Dr. McKeown is Chief, Metrology Division, Bedford Institute of Oceanography, DFO, Dartmouth, Nova Scotia.



4. Commercial Development of Salmon Aquaculture in the Maritime Provinces

*R.E. Drinnan, D.J. Scarratt, J.E. Stewart**

As currently practised in the Atlantic Area, commercial salmonid aquaculture involves the freshwater rearing of salmonids (salmon, trout) from eggs to juvenile fish large enough to survive transfer to saltwater as smolts. They are retained in anchored, suspended net cages at inshore sites and fed prepared feeds over a period of 6-18 months, to sizes appropriate for marketing as human food ranging from 8 oz. to 12 lb. The

Department has a long history of salmonid hatchery operation and physiology, disease and nutrition studies associated with its mandate for protection and conservation of natural stocks. This has resulted in a considerable body of biological and technological expertise.

Awareness of the developing salmonid culture industry in Europe, especially in Norway, the apparent potential for a similar development in Eastern Canada,



and initiation and failure of a multimillion-dollar commercial development effort in salmonid farming (Sea Pool Enterprises) was followed by a major development in marine farming by the Cape Breton Development Corporation (DEVCO). This venture, which was designed to avoid the mistakes which led to Sea Pool's demise, provided an opportunity to utilize DFO expertise in a variety of ways: transfer of applicable technology, direct participation in the early exploratory developments, continuing technical advice and troubleshooting (including disease diagnosis and treatment) and the development of relevant technical R&D programs.

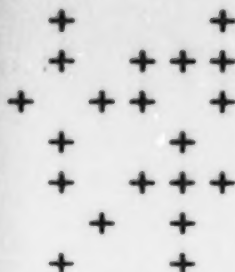
The DEVCO developments in Cape Breton and parallel field trials by the former Resource Development Branch were the initial focus for commercial development. The R&D component of DEVCO was headed for the six years of its existence by a DFO scientist on secondment. Early field trials in both Nova Scotia and New Brunswick and DEVCO technical staff training were carried out under contract by DFO staff. These confirmed the potential for salmonid aquaculture and identified low winter water temperatures as an influential site and strategy factor (most fish, including salmonids, cannot survive temperatures less than -0.7°C). As a result, the Cape Breton program adopted seasonal rearing of Rainbow trout as a commercial endeavour and began commercial scale operations in 1974 with continuing DFO input, particularly in the areas of nutrition and disease. An effective moist pellet feed was developed and vibriosis was identified as a major mortality factor. An oral vaccine was developed in the DFO Halifax Laboratory, field-tested and shown to be effective. This led to the later development by a Canadian pharmaceutical company, Connaught Laboratories, under the leadership of a seconded DFO scientist and with DFO financial support, of a series of fish vaccines now in private sector production, and also to the formation of a spin-off company, Aqua-Health.

In the seventies, DFO staff reassessment of the early discouraging exploration in southwest New Brunswick led to the hypothesis that sites outside Passamaquoddy Bay offered promise of overwinter survival. Many of the areas enjoyed a high energy regime of high tides and thus complete mixing of waters, thereby avoiding the lethal temperature of -0.7°C , albeit only narrowly. A joint federal-provincial (DFO and New Brunswick Department of Fisheries) program involving a private contractor field-tested a Deer Island site from 1978-80, demonstrated the commercial potential and marketed the first crop in 1979. The resulting private farm inspired the development of the current industry, which now has 6 companies well established and 26 more in development. Some half-dozen companies at various stages of development are also in production in Nova Scotia, as a result.

The availability of seedstock (Atlantic salmon smolts) to sea cage farmers has been a major growth limitation throughout development. In the early years, the only supply was provided by federal hatcheries. This fixed moderate allocation, which began at 25,000 per year and rose to a current 150,000 or more per year, was designed to support the industry during its progress toward self-sufficiency. This was encouraged and facilitated by technology transfer and provision of fish at early life history stages (eggs and fry) to beginning commercial hatchery operators. Allocations were managed by a federal-provincial Salmon Seedstock Committee which, with the burgeoning increase in the private supply of smolts, is converting to a coordination role and provision of a back-up supply of smolts.

The expanding industry has created a proportionate demand for feed, originally all imported to the region. DFO nutritionists have been active in developing improved open-formula feeds and providing a quality monitoring service and ongoing advice to major regional producers of both moist and dry formulations.

At a number of mainland Nova Scotia sites the DFO program continued to explore site potential and a variety of aspects of rearing technology. Continuing



Disease is a major factor in industry viability and continuing development. The Fish Health Service Unit continues to provide diagnostic, advisory and monitoring services and administers programs designed to minimize disease transmission via industry transfers of both eggs and smolts. To date, through the industry of this unit and the timely provision of the Fish Health Protection Regulations, major problems with disease have been avoided or dealt with.

The early DFO programs demonstrated the importance of stock selection and identified superior river stocks (from the Saint John River), which are now generally used in New Brunswick. DFO has provided considerable assistance and leadership in developing the all-important Atlantic salmon broodstock in Nova Scotia and New Brunswick. These four-year development programs rely on DFO hatcheries for growth of the fish to the smolt size, following which the commercial operators grow them out to sexually mature broodstock.

A significant development, which is likely to be critical in continuing industry growth, is the establishment of the Salmonid Demonstration and Development Farm, a federal-provincial initiative with Economic Regional Development Agreement (ERDA) funding. Located in the heart of the salmon-growing area of New Brunswick, this is a commercial-scale facility that carries out evaluation, develop-

ment and demonstration of equipment, husbandry strategies, feeds and stocks. It works closely with DFO scientists throughout the Scotia-Fundy Region and is closely involved with all phases of the development of the industry. The program is managed by an advisory committee of federal, provincial and industry representatives, and a technical committee of DFO and other scientists expert in the areas of physiology, nutrition, genetics and disease. It is projected that the facility could become virtually self-financing within the next year with the production of marketable fish, plus minimal industry and government support.

Economic Potential

In 1986, the salmon-rearing industry in the Atlantic provinces marketed 300 tonnes of salmon, with a farmgate value of \$3.5 million. In 1987, this is expected to increase to 1,000 tonnes and \$11.0 million, and by 1989, 2,200 tonnes and \$25 million. It is anticipated that in southern New Brunswick alone, by the early 1990s, some 50 farms will be producing around 5,000 tonnes a year with a value of \$50,000,000.

*Mr. Drinnan is Aquaculture Co-ordinator, Dr. Scarratt is Head, Disease Nutrition and Molluscan Culture, and Dr. Stewart is Director, Biological Sciences Branch, Scotia-Fundy Region, DFO.

5. The DOLPHIN Project

*Robert Pietrzak**



Introduction

DOLPHIN (Deep Ocean Logging Platform with Hydrographic Instrumentation and Navigation) is a hydrographic system that includes remote-controlled semi-submersibles along with launch and recovery systems designed to improve the density of depth-sounding coverage on the continental margin. The project began in 1982 as a DSS Unsolicited Proposal, under the sponsorship of the Canadian Hydrographic Service (CHS) at BIO, with a contract to International Submarine Engineering Ltd. (ISE), Port Coquitlam, B.C. for the design and construction of a "proof-of-concept" prototype.

The success of this prototype led to a second contract under the DSS Source Development Fund to produce three more vehicles, an engineering prototype that was delivered in late 1985 and two production models that were completed in mid-1986.

DOLPHIN deployment, trials and instrumentation have been developed by CHS and engineers at BIO. The design parameters of DOLPHIN were developed through close interaction between CHS and ISE.

The DOLPHIN hull is cylindrical, 1 m in diameter with a spherical nose and a tapering aft section. The hull is 7 m in length with a snorkel-mast 4.6 m high. A 500 kg lead keel is attached to the underside of the body; overall, the vehicle weighs about 3,000 kg. Propulsion is provided by a 150 HP turbocharged marine diesel engine.

DOLPHIN involves the integration of five technologies: positioning of the vehicle; depth, attitude and speed control; full duplex radio for control, navigation and data signals; depth measuring sonar; and hydrodynamically stable forms. DOLPHIN uses dynamic controls in all three axes to

minimize pitch, roll and yaw motions, and to maintain the vehicle at the desired depth.

To date, the DOLPHIN fleet represents an investment of \$3.6 million by the Government of Canada. DFO, EMR, DND and DSS have contributed to this funding. For the past four fiscal years, the operation, maintenance and development cost of DOLPHIN has averaged \$240,000, 60 per cent of which is estimated to have remained in the local economy.

The Offshore Survey Task

Canada has a vast offshore area extending over one million square nautical miles. The area contains valuable natural resources, including huge fish stocks, hydrocarbons and other mineral deposits. These seas are continuously traversed by merchant shipping and are patrolled by naval, Coast Guard and Fisheries vessels. For the proper governance of this extension of Canada's realm it is essential that the area be adequately surveyed and charted.

It was not until the 1950s that the advent of electronic positioning systems allowed survey vessels to be positioned with accuracy out of sight of land. At that time, CHS, using the Decca system, started to systematically survey the bathymetry of its offshore waters. Starting in the waters close to Nova Scotia it progressively extended these surveys to the Grand Banks of Newfoundland. On the Pacific coast similar offshore surveys were carried out.

In the 1960s interest in marine geophysics, particularly in the use of ship-board gravimeters and magnetometers, led to the combination of bathymetric measurements and the start of a systematic program of multiparameter surveys. Over the years these surveys have been extended up the east and west



coasts of Canada and, using rather different techniques, have also been carried out in the Arctic. Basic coverage of the Pacific coast has now been completed and has been extended northwards as far as Davis Strait on the Atlantic coast.

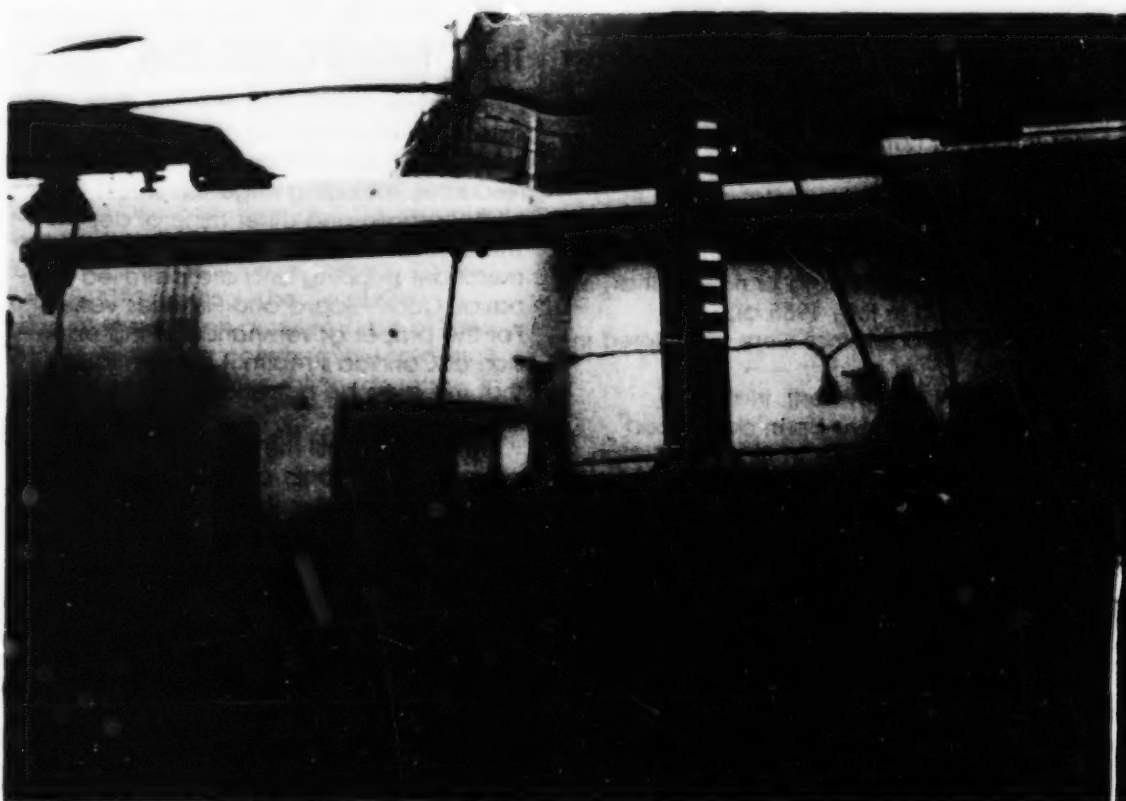
The concept of using remotely controlled "satellite" vehicles for improving the cost-effectiveness of offshore surveys and densifying the coverage of multiparameter surveys was developed at BIO in 1965. By running these vehicles parallel to a parent vessel it was, and is, planned to densify the precise profiles and not only expedite the task but considerably increase our knowledge of the offshore bathymetry.

In trials of the "proof-of-concept" DOLPHIN, the remote-controlled vehicle has been found sufficiently versatile as to lead to speculation that it may also have

some use in coastal as well as offshore surveys, possibly using a single pair of vehicles with a major launch as the controlling vehicle.

DOLPHIN was designed to satisfy the requirements of CHS but has subsequently attracted the interest of other users, notably the U.S. Navy, which has identified a number of uses for it. Two vehicles similar to DOLPHIN, but named Sea Lion, have been delivered to the U.S. Navy.

Several other navies have shown a keen interest in DOLPHIN, and one major American oil company has already conducted a series of tests to evaluate its potential for seismic profiling.



The DOLPHIN Vehicle

The early work at BIO on remote-controlled vehicles started in 1965 and was directed towards the development of small surface craft. A 4.4 m launch with a deep-V hull was used and equipped with hydrographic instruments. Control was provided by an RF link, which proved to be less than reliable because of interference with other communications. In calm water, with speeds in excess of 15 kn, the launch manoeuvred and collected data as planned, but in moderate seas, it spent much time airborne with consequent loss in power and speed. For these reasons, the project was abandoned in 1973 and not revitalized until 1981.

ISE, under contract to DFO, examined several kinds of hulls and concluded that a semi-submersible vehicle was the most likely to succeed. It was proposed that a cylindrical body 1 m in diameter and 5.5 m in length be used. Power would be provided by a 6-cylinder, naturally aspirated engine, and air would be drawn in through a snorkel tube equipped with freely rotating fairings to reduce drag and maintain stability in turns. Exhaust would be underwater. The vehicle's operating depth would normally be set for 3 m, giving a keel draft of 4.5 m.

Vehicle Trials and Developments

The "proof-of-concept" vehicle was delivered to BIO in September 1983 and was given its first operational sea trials in December. Operating from the survey ship *Baffin* in the area off St. Margaret's Bay it demonstrated its dynamic stability and its response to control from the parent vessel. It ran at its designed speed of 14 kn and dived, surfaced and manoeuvred as per specifications. One of its few weaknesses was the radio link, which did not meet the specifications with respect to range.

Manoeuvring at slow speeds when coming alongside the ship for recovery proved to be difficult, particularly with DOLPHIN on the surface. Launching and recovery on these first trials was through a makeshift arrangement using a pair of the ship's launch davits. This meant that the operation could only be carried out in low sea states.

The following summer, the "proof-of-concept" vehicle was again taken to sea on *Baffin*, mainly to evaluate hydrographic instrumentation for positioning and depth measurement as well as to conduct further trials on the vehicle itself. Advances in the davit handling system were also evaluated.

In the fall of 1985 this version of DOLPHIN was taken on its final major cruise, once more aboard *Baffin*, in the area of Grand Manan Island. Using a precise navigation system and specially developed software, the DOLPHIN was operated under complete computer control along preplanned survey lines with an accuracy of four m. This was an important step forward in developing control systems for a fleet of DOLPHINs.

A second DOLPHIN, the engineering prototype, was initially evaluated in December, 1985 at the ISE facility in British Columbia. The basic characteristics of this vehicle were not much different from the original, although certain features such as a turbocharged engine, a large electronic compartment and a folding snorkel had been added. Component parts that were failure-prone in the earlier model had been replaced with more reliable units.

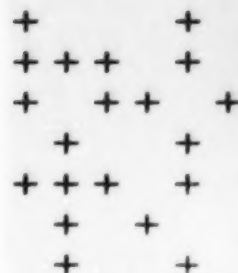
Following the initial trials of the engineering prototype, construction began on the two production prototypes. These were delivered in mid-1986.

Depth Measurement

Although DOLPHIN has the potential for carrying a variety of geophysical sensors (seismic, temperature, biological), it was decided initially to concentrate only on depth measurement. In 1984, the FDO 444 echo-sounding system was fitted and successfully used on a test cruise. The system is analogue, with the data displayed as a graph aboard the parent vessel. On this and the subsequent experimental cruise in November 1985 the echo-sounding records were considered to be of superior quality.

Launch Recovery

The recovery of floating instrument packages at sea in heavy weather is not an easy task. From the start BIO staff knew that considerable ingenuity would be required to develop a launch and recovery system for DOLPHIN.





In order to get the basic sea trials underway as early as possible, it was decided to use the shipboard equipment installed to handle the original DOLPHIN.

During the initial trials, *Baffin's* luffing davits were used and wire slings were hooked on manually from an inflatable outboard in the water. In subsequent trials, a steel beam was suspended from a pair of gravity davits by short straps with hooks attached to the beams. Long poles were used to hook the straps onto the vehicle directly from the deck of the ship. In spite of this progress, it was felt that it was weather limited and far from ideal.

Production DOLPHINs at Sea

Much had been learned from the trials of the "proof-of-concept" and engineering prototype DOLPHIN over the previous years. *Baffin's* 1986 fall cruise into the Bay of Fundy represented the first sea trials with the new DOLPHINs and all the developments that had been incorporated into them.

A refined launch and recovery system was used regularly during the one-month cruise, and it operated successfully in Force 4-5 seas. The DOLPHIN crew was quite optimistic about operation in Force 6 seas with a few special provisions.

The first experiments in "in-flight" refueling of the vehicle were also successful. This involved hooking DOLPHIN to its recovery position at a speed of 6 kn and taking the vessel in tow. A special fitting at the end of a fuel hose was pushed onto the fueling port by the force of the water.

Excellent quality echo-sounding signals and good Loran-C data were telemetered to *Baffin* from DOLPHIN. Both of these components were adapted to the special needs of DOLPHIN by contracts to two Halifax-area firms, RC Marine Electronics (Loran-C), of Dartmouth and Femto Electronics (echo sounder) of Sackville. These were integrated into DOLPHIN's command and telemetry system with the help of a special-purpose, BIO-designed controller. (RC Marine had reported that other customers had expressed an interest in remote-controlled Loran-C receivers.)

Because of the success of the 1986 trials, plans were made to use the two DOLPHINs together during the fall of 1987 on an actual survey. The mission was to verify the U.S. sidescan survey results from the British system GLORIA, between Georges Bank and Emerald Bank on the Nova Scotia Margin. Equipped with new parts and minor modifications, *Baffin* set sail in early November. One DOLPHIN suffered a throttle system failure and was subsequently damaged during its recovery. The project was terminated and will be resumed when a more adequate handling system for failed vehicles is put in place for use in the offshore.

International Submarine Engineering

By 1981, ISE had established itself as one of the three world leaders in the technology of ROVs (remotely operated vehicles). During the late 1970s and early 1980s, discussion between the offshore exploration industry and government had revealed that there was a real need for autonomous vehicles, and ISE developed a concept for meeting this need. The company then obtained UP funding to bring the concept to fruition.

The selection of a semi-submersible hull for the autonomous vehicle was innovative, as this was thought to best meet the stability, speed and control requirements. To this, ISE must be given credit for its excellent interpretation of the type and design of vehicle required. At DOLPHIN's inception, a 1/3 scale model was built and tested in a tank at the B.C. Research Institute.

During this development period, ISE held several discussions about the concept with the U.S. Navy's Office of Naval Research and with other departments of the U.S. Navy. ISE also had received help and technical advice, without charge, from persons at the David Taylor Naval Ship Research and Development Centre.

The DOLPHIN trials of 1983 and 1984 with *Baffin* provided ISE with actual "at sea" durability tests on the vehicle. These were closely followed by the U.S. Navy, which purchased two Sea Lion vehicles.

Following the successful deployment of the two production prototype DOLPHINs in 1986, ISE had procured, under the Defence Industry Productivity Program (DIPP), Federal Government loan assistance of \$2.3 million for the provision of four additional DOLPHINs, together with a design for a launch recovery system. This generation of DOLPHINs will incorporate navigation algorithms for running and manoeuvring. These were developed by ISE for autonomous vehicles such as Autonomous Remote Controlled Submersibles (ARCS) and DOLPHIN. As part of this program, DFO has made a commitment to supply 60 days of ship time for launch and recovery trials with multiple vehicles.

DOLPHIN and Publicity

DFO has made a considerable effort to promote DOLPHIN locally and internationally. Following the success of the original trials, DOLPHIN became the topic of many papers and presentations to hydrographic, surveying and marine transportation interests.

During BIO's Open House in 1984, the newly acquired DOLPHIN was the most popular of all the displays. DOLPHIN was highlighted at the BIO display at the Canadian Offshore Resources Exposition in Halifax, during October 1985. (Unfortunately, owing to the downturn in offshore exploration, the show was not well attended.)

The Public Relations staff at BIO ensured DOLPHIN exposure to the local media. This was done, in part, to explain to the commuting public the presence of an unusual submarine travelling in the Bedford Basin. BIO also participated in arranging for DOLPHIN's display at Expo '86 — Underwater and Offshore Resources. Shortly thereafter, in September, DOLPHIN was loaned to ISE for demonstrations at IOS.

DOLPHIN was loaned to ISE again, in early 1987, for its display at the International Hydrographic Conference at Monaco in May. This event is held every five years and is attended by senior hydrographers from 60 to 75 countries. DOLPHIN was also highlighted at Oceans '87, an international

conference in Halifax where the Minister of Fisheries and Oceans announced the Oceans Strategy for Canada.

Recent Developments

ISE has entered into an agreement with Rockwell International, a major U.S. military contractor, so that a position can be staked in the U.S. Navy Autonomous Underwater Vehicle market.

In September 1987, the DOLPHIN engineering prototype was loaned back to ISE for systems development. ISE has been under contract to the U.S. Defence Advanced Research Projects Agency for the development of a mine counter-measures route survey system.

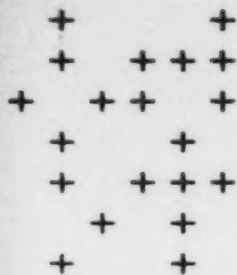
Economic Potential

The development of DOLPHIN, along with another CHS-sponsored project ARCS (now abandoned), has created within ISE an Autonomous Vehicle Division. Since 1985, this has employed 35 people.

The potential DOLPHIN or related autonomous vehicle market is estimated to be in the range of 700 units; sales could gross \$450 million. CHS is committed to supporting ISE in developing DOLPHIN vehicles for hydrographic surveys and in marketing the DOLPHIN technology on an international basis.

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*Mr. Pietrzak is with Hydrographic Publications, Canadian Hydrographic Service, DFO, Bedford Institute of Oceanography, Dartmouth, Nova Scotia.



6. DFO Biological Science Contributions

James E. Stewart*

Gaffkemia

G*affkemia* is an invariably fatal bacterial infection of lobsters caused by a virulent form of *Aerococcus viridans* var. *homari*. DFO studies have shown that the pathogen can exist in the wild for many months and enters the lobster through wounds in the integument brought about by fighting or poor handling in commercial holding units. The time from infection to death is strictly temperature-dependent. These findings have led to protocols to reduce losses among commercially held lobsters through improved handling, refrigerated tanks, tanks to hold individuals separately to prevent fighting, and ultimately to development of means to induce resistance in lobsters to the disease. A vaccine is now commercially available as a direct result of DFO studies.

Georges Bank

The dispute over the delineation of national territories in the Gulf of Maine area was resolved in 1984 by a decision of the International Court of Justice (ICJ) in The Hague. The ICJ ruled that a single maritime boundary between the United States and Canada would cut across the Georges Bank, a rich scallop fishing area, and give the bountiful Northeast Peak to Canada. The scientific underpinning upon which so much of Canada's case rested was based upon DFO research and documents prepared by DFO scientists of this region.

One-Year Smolts

The Mactaquac Hatchery, because of low water-temperature, was only able to produce two-year smolts, i.e., it took two years in fresh water from egg laying to reach a size at which the fish could be transferred to salt water. The highly imaginative work of DFO scientists who exploited the availability of warm water in volume from the New Brunswick Power Company generating station at Mactaquac (cooling water from the bearings), with money from the power company as well as DFO and CEIC to build an accelerated rearing extension to the Mactaquac Hatchery, has revolutionized the operation. As a result of the construction of the early rearing unit, the hatchery can now produce one-year-old smolts routinely at a substantial savings per fish: \$1.10 versus a cost of \$2.25 for two-year smolts.

*Dr. Stewart is Director, Biological Science Branch, Scotia-Fundy Region, DFO.

7. Relationships Between BIO Scientists and the Private Sector

*D.L. McKeown**

Towed Body Positioning System

DFO collaborated with EMR, DND and NRC on a \$5.3 million PILP contract to Hunttec'70 Ltd. to produce a deep towed survey system. A towed body positioning system was purchased from a subcontractor, Oceano (USA) Ltd. DFO staff conducted sea trials of the system because Hunttec lacked the necessary expertise. Deficiencies identified during those trials were reported to Hunttec and eventually rectified by Oceano. Thus, Hunttec'70 Ltd. added a proven body positioning system to its line of survey system products.

Laser Diode Pressure Sensor

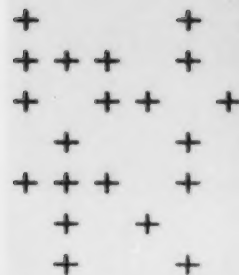
The Seakem Group undertook the development of a laser diode pressure sensor with DFO support via the UP system (UP-S-494, completed in 1985). In a sense, this development was a failure; no commercially viable pressure sensor was produced. However, a commercial ultra stable laser diode power supply was produced as a direct result of the development (a product not foreseen at the time of the original UP). In addition, the company established fibre optic expertise used in subsequent products, including a high resolution, high accuracy temperature sensor. The subsequent developments also created three permanent jobs — a significant percentage increase for a small company.

Guildline CTD

The development of the Guildline CTD is an excellent example of a beneficial symbiotic relationship between DFO, NRC, and the private sector. The initial involvement of DFO in the late 1960s in evaluating prototype instruments expanded into direct involvement in development of the digital CTD; this instrument is the workhorse of physical oceanography. The attempts by DFO oceanographers to use the CTD at the limits of its capabilities have been the spur for successive improvements in the design while at the same time ensuring DFO maintenance of world-class capability in the measurement of salinity. A number of other instruments, such as the AUTOSAL laboratory salinometer and MINISAL portable salinometer, are direct results of the CTD development.

"AUTOSAL" Laboratory Salinometer

This instrument was developed by NRC and Guildline Instruments in 1973. Outstandingly accurate results obtained by DFO scientists in an international salinity intercomparison, backed by the established reputation of the DFO salinity measurements, led to immediate international acceptance of the instrument as the standard laboratory salinometer. It is still used in every major salinity laboratory in the world.





"MINISAL" Portable Salinometer

AGE Instruments, supported by DFO and DSS, has developed a portable salinometer having accuracy similar to laboratory instruments. The major DFO contribution to this development has been in carrying out a series of evaluations of prototype instruments. World-class expertise in salinity measurement has been applied to pinpoint design problems, enabling the manufacturers to implement successive refinements. This DFO expertise has helped the instrument achieve acceptance by the international community. To date, more than 200 units have been sold.

Numeric Modelling of Tidal Currents

A DFO research requirement led to a contract with Martec Ltd. to construct a fully representative two-dimensional tidal model, first for the Scotian Shelf and later for Grand Banks. Modelling expertise in DFO transferred to Martec Ltd. (and later to ASA Consulting Ltd.) provides the basis for a fully operational model of shelf water circulation, including wind-driven flows.

It is being used commercially by the consulting industry to produce storm surge models, to predict sediment movement near any proposed seabed structures and to predict pollution movement from identified sources. It has direct links with other industry and government studies of ice-berg trajectories and dynamics and wave-current interaction.

Wave/Ice Interaction

DFO/PCSB/BIO in conjunction with the Canada Centre for Remote Sensing (CCRS) are studying the ice dynamics of the Newfoundland/Labrador ice margin (LIMEX Project). The wave/ice interaction in this region is being studied under the UP program by MacLaren Plansearch with a sub-contract to C-CORE to study ice properties and ice motion. Ice/wave/structure interaction at the Hibernia site is a significant cost restraint on development of the oil field. As a result of the government/industry/university interaction on this problem, the private sector is gaining the competence to address a high-priority oil industry need based on technology transfer and development acquired while a multi-agency/multi-disciplinary study is underway.



Surface Current Model

DFO has collaborated with the Meteorological and Economic Planning Company (MEP Ltd.) in the incorporation of a BIO research-type numerical oceanographic model into the operational real-time surface current trajectory forecast model MEP had originally developed for AES. The basic development work was done via an NRC PILP grant of \$200,000 and was coordinated by a steering committee headed by DFO and made up of representatives from other government departments and the oil industry. MEP and DFO have nearly finished the second phase of enhancement and testing using data from CASP under a UP of \$45,000. The project has given the company a significant oceanographic modelling capability to complement its meteorological skills.

High-Frequency (HF) Radar

DFO has collaborated with and supported C-CORE at Memorial University via OERD contracts, science subventions and core grants to develop a two-site HF radar system for the remote sensing of oceanic surface currents. The concept and some of the hardware and software were acquired from the U.S.; the major portion, though, was developed by C-CORE. BIO has used the system in support of several oceanographic experiments, and it will be used next year by IOS. Following successful demonstrations of the system, further development by C-CORE to extend the capabilities to measuring surface wave parameters, detecting iceberg vessels and planes, and operating at increased detection range has attracted support from NSERC, DND and the oil industry, as well as DFO. The project is now a well-established part of the C-CORE research plan.

Tidal Models for Oil Slick Tracking

Tidal modelling work done at BIO is the cornerstone of a PILP and a UP to develop and test an enhanced oil slick tracking model. MEP Ltd., already established in the field of oil slick tracking, felt that models needed better oceanographic information for improved prediction. A BIO

model is being used to make the predictions about currents that are necessary to follow an oil slick's path. Data from the 1986 CASP program are being used to verify the model, including the tracking of the drifter buoys developed under a separate UP by Seimac. The model development is being followed closely by representatives of the offshore oil industry, who are helping direct the work through a steering committee. MEP has already received inquiries concerning the product and has plans to further develop the model for iceberg tracking.

Satellite-Tracked Ice Beacon

DFO's requirement to study the interannual variability of the ice-cover properties of the Labrador and Newfoundland shelves has generated the development of a set of helicopter deployable, satellite-tracked ice-beacons in collaboration with MetOcean Ltd. of Dartmouth, N.S.

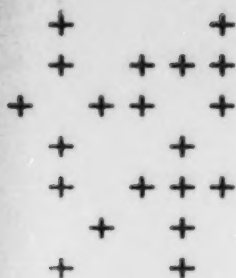
The ice-beacon's sophistication ranges from simple location beacons to an ice-monitoring platform measuring oceanographic, ice and atmospheric parameters. In producing the specified required ice-beacons for BIO's research projects, MetOcean Data Systems Ltd. has developed its own line of satellite transmission products and environmental sensors, which are being field-tested in DFO's programs. The successful data return of the various ice-beacon types in past winters has encouraged MetOcean to continue its development of satellite ice-beacon products and market them for other marginal ice zone researchers.

The Stable Tower

An offshore stable tower for air-sea interaction studies was designed by Whitman Benn Engineering Ltd. of Halifax, fabricated by Stuart Industries Ltd. of Fall River, and maintained by Dominion Diving Ltd. of Dartmouth. All these firms have since benefitted from expertise developed during this work by participating in offshore oil exploration work.

In particular, Whitman Benn, which did not previously have substantial marine experience, has headed up a multimillion-dollar design study for a Sable Island pipeline.

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ARGOS Drifting Buoys

ARGOS satellite-reporting buoy and ice-drifter technology has been developed by three Nova Scotia firms (Hermes Electronics Ltd., Seimac Ltd., and MetOcean Data Systems Ltd.), in response to contracts from BIO and other government agencies. Drifting buoys were developed first to report atmospheric pressure and water temperature as a Canadian contribution to the Global Atmospheric Research Program (GARP). The present healthy competition situation is resulting in ongoing development of new products for a world market. Ice-beacon drift data and technical reports are being supplied to Petro-Canada Ltd. and are available to other users on request.

The Battfish System

The Battfish remotely controlled variable depth towed vehicle and comparison towing system was developed by PCSB to do physical and biological oceanographic studies. Guildline Instruments Ltd. acquired the licence to commercialize the technology. The firm has sold 15 Battfish vehicles at \$50,000 each; several included other components such as a CTD, a winch, or a computer, raising the total cost of the system to as high as \$250,000. Through the sales of this unique vehicle, Guildline has expanded the market for its entire product line.



Optical Plankton Counter

The instrument was developed for DFO requirements and patented by BIO. AGE Instruments Ltd. secured a licence to manufacture it from Canadian Patents and Development Ltd. (CPDL), and technology transfer from BIO to AGE commenced in 1984. AGE also secured a UP from DSS in 1986 for \$155,000 (\$30,000 from DFO) to modify the instrument for application in turbid waters. International interest in the product has resulted in orders from the Kiel Institute of Germany



for both laboratory and submersible versions while the Marine Fish Division of BSB, DFO is ordering a submersible version. BIO is continuing its transfer by assisting AGE with field trials of the commercial version. The company is actively promoting the instrument at trade shows, where it is receiving a very favourable response.

Fluorometer Remote Head

Technological ideas originating in DFO have also sparked development projects in industry. The concept of taking an inexpensive laboratory fluorometer and converting it to a shipboard fluorometer capable of vertical profiling was taken up by Focal Marine Ltd. of Bedford, N.S. and developed through a DSS UP grant of \$100,000 during 1985/86. PCSB acted as consultant and scientific authority for the UP, and field trials of the prototype were conducted in ice-covered waters of the Arctic and in the Bedford Basin. The prototype proved successful and Focal has pursued licensing from CPDL and the potential conversion of the prototype into a commercial instrument.

Custom Machining, Optical Plankton Counter

In the course of technology transfer of the optical plankton counter, AGE subcontracted the machining of the entire instrument to a local Mount Uniacke firm, Custom Machine and Tool Co. (CMT). PCSB established the link between AGE and CMT, and also provided final drawings and quality control during the construction process. Four orders for optical plankton counters have been processed by CMT; future orders will be managed directly between the two companies, with PCSB acting in a consulting capacity. In the future, units constructed by CMT will be pressure-tested at Seimac Ltd. with PCSB initially providing specifications and quality control and later acting in a consulting capacity only.

Radionuclide Extraction System

Existing radionuclide detection and analytical expertise in the Marine Chemistry Division of PCSB Scotia-Fundy Region was utilized by Seakem Oceanography Limited of Victoria, B.C., in meeting a commercial demand for an in-situ extraction method for radionuclide measurement in water. The company had developed, and successfully marketed, an *in situ* pumping system for the collection of samples for chemical analysis of water but its clients wished to extend the system to determine

radionuclides. The Marine Chemistry Division assisted Seakem by adapting the sampling methods employed in research and nuclear power station monitoring programs. The potassium ferrocyanide column and manganese dioxide column developed for this purpose have been successfully marketed by Seakem in Canada, the United States, the United Kingdom, Italy and France to monitor radionuclides disseminated in the Chernobyl fallout, through reactor releases and by natural processes.

Portable Field Kit for Organohalogen Measurement

The initial concept for a simple and expedient method of measuring trace quantities of organohalogens (DDT, PCBS) was formulated by the Marine Chemistry Division of PCSB Scotia-Fundy Region. The idea has been further developed by Seatech Investigation Services Ltd., under financing from the Ocean Dumping Research Fund, to produce a portable field testing kit. This kit, based upon thin-layer chromatography, has been refined and tested under a cost-sharing arrangement with the Atlantic Institute of Biotechnology. The kit enables regulatory agencies to obtain rapid semi-quantitative results for the concentrations of various halogenated compounds in the event of a spill or for surveying previous dumps (for example, one at a DEW line in Labrador). The kit will be marketed commercially by Seatech, which has already reported interest from Environment Canada and private contractors excavating abandoned dump sites.

Halifax Scientific Consulting Firm

In the conduct of research supported by the Panel on Energy R&D (PERD) into the rates and modes of natural degradation of Scotian Shelf condensate and Hibernia crude under actual field conditions on the east coast of Canada, increased private scientific consulting expertise has developed in Halifax. The contractual portion of the research has resulted in the establishment of a small consulting business, Kenneth Lee Research Limited, which has

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created employment for several individuals and is forming a nucleus for contract research into various applied aspects of microbial ecology. Further work on this project is likely to produce a commercially viable means of enhancing beached oil degradation via the application of inexpensive agricultural fertilizers containing the appropriate nutrients. This will provide a more efficient and cost-effective procedure for cleaning fouled beaches than those commonly employed in the past.

Oceanographic Data Software for ARGOS Satellite Transmittal

A \$1500 contract was given to Met-Ocean Data Systems for the design of software to transfer data from standard oceanographic sensors such as temperature and pressure, and convert them to standard SI units for transmission on the Argos Satellite System. BIO mounted these two systems in thermistor chain buoys and tested them in the field. The company now has a standard software package that can be used to support the needs of BIO and others wishing to collect oceanographic data.

High-Pressure Test Services for Industry

The Metrology Division maintains a high-pressure (1500 psi) test facility to support internal equipment development. Free testing services are offered to those companies actively involved in developing equipment under government contracts (26 occasions in the last year). Because of the very specialized nature of the equipment, assistance has been made available to other companies, primarily in the fishing equipment supply business, to allow testing of new products or to help isolate manufacturing process defects in existing product lines. Companies assisted include Brooke Ocean Technology, Selmac, IMP, Can-Am Containers, Sea-Chem, N.S.R.F., Dalhousie, Lobsiger and Associates, Ocean Technology, MacLaren Plansearch, Huntex, and Arctic Sciences.

Oceanographic Mooring Winch

BIO engineers conceived and eventually patented a novel system for handling long lengths of synthetic oceanographic mooring line, ashore and at sea. A \$15,000 contract to produce an engineering design based on the BIO operating principle was awarded to Hawboldt Industries; this was followed by two \$50,000 contracts for the production of two operational systems. The company has produced documentation on the system and has received some international inquiries about the product.



Electric Rock Core Drill

In support of AGC the Metrology Division developed a tool for sampling hard rock to a depth of 6 m in Continental Shelf water depths. Through CPDL a licence to produce the drill was given to NORDCO, of Newfoundland. Production drawings, specifications, manufacturing procedures and some specialized tooling were transferred to the company. In addition, NORDCO personnel were trained at BIO on some aspects of component production and in drill operation. Since that time, the company has exported two systems (to Goa and Norway) at an estimated sale price of \$250,000. The company now has some unique expertise which it has been able to transfer to other related developments.

Continental Shelf Geological Sampling Developments

Under the terms of a \$660,000 PILP contract between NORDCO, AGC, and DSS, a novel sampling device for the recovery of unconsolidated sediments was produced. A Metrology engineer was seconded to NORDCO, along with a colleague from Dalhousie, to assist the firm in the conceptual design of the device. The company evolved these original design concepts into a full-scale working prototype, which was tested on a BIO vessel under the direction of the Metrology engineer acting as cruise Senior Scientist. The device, which the company has employed on offshore surveys, is unique in the world and allows NORDCO to offer an equally unique service.

Ametek Straza Support Contracts

DFO awarded Seimac Ltd. a standing offer covering the service, maintenance, and user support of two Ametek Straza Doppler Current Profilers for the period of December 1984 to March 1986. In preparation, one Seimac senior engineer and one technician received initial training

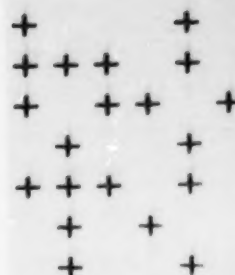
supervised by BIO personnel and additional special assistance at various points during the contractual period. The accumulated technological expertise allowed Seimac to successfully negotiate several additional contracts, notably with EMR and McElhanney Services Ltd., for installation of the Doppler Profilers on DFO and private vessels, while performing over \$25,000 of work on the original standing offer. In FY 87/88 the standing offer was transferred to Offshore Marketing International, which is presently acquiring a similar level of expertise. Therefore, two companies will be highly qualified to bid on Doppler technology contracts in both government and private industry.

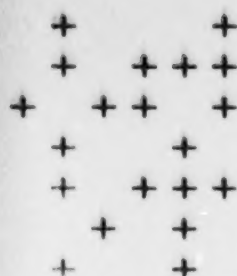
Electronic Thermometer

A robust, low-cost, hand-held electronic thermometer has been developed by Vemco Ltd. of Halifax County in collaboration with BIO. The *in situ* temperature is locked on the display four minutes after deployment. The present model is the fourth generation of development and is being purchased by fishermen to use for selective fishing (e.g., low temperature for cod) and to ascertain storage temperatures for fish and lobster.

Monitoring of Aquaculture Sites

Temperature and salinity at aquaculture sites can be monitored by acoustic telemetry devices now under development by Vemco Ltd. of Halifax County in collaboration with BIO. These low-cost devices will be based on fish-tag acoustic transmitters and will be used extensively when conditions are critical to the stocks. In addition to small producers, Clearwater Fine Foods and National Sea Products have expressed a keen interest in the devices.





8. Technology Transfer From BIO

*H.B. Nicholls, G. Selbert**

CTD Winch

Company

Hawbolt Industries Ltd., Chester, N.S.

Description of Item

High-speed shipboard winch for lowering and raising oceanographic instruments, such as CTDs, that are used at great depths.

Technology Transferred

Information and technology developed at BIO in the field of hydraulic, servo-controlled winches and automatic spooling mechanisms.

History of Events

BIO needed a state-of-the-art oceanographic winch to replace equipment that had been in service for many years.

Value of Support

From BIO:

• 10 per cent of engineers' time during extent of project	\$ 4,500
• materials	17,500
• ship time for testing winch	23,600
Total	\$ 45,600

From external sources:

• NRC (PILP grant)	1985/86	\$ 66,000
	1986/87	71,519
	Total	\$137,519

Benefits to BIO

The Institute acquired a state-of-the-art winch for \$45,600.

1987	\$156,000
1988	\$332,000
1989	\$528,000
1990	\$653,000
1991	\$792,000

Oceanography

Company

sea trials have proven it to be a stable platform from which hydrographic surveys can be conducted. A second contract was awarded in 1984 for the construction of three production-prototype vehicles, which were delivered in the summer of 1986.

Remote-controlled, semi-submersible vessel used to survey the seabed for production of navigation charts.

General survey approach used in a remote-controlled surface vessel developed by BIO, and other technical details.

In 1981, a contract was awarded to ISE to construct a prototype vehicle. This vehicle was completed in 1983, and subsequent



From BIO:

- engineering and hydrography expertise
- ship time for trials

	\$	87,227
		88,000
Total		175,227

- DSS (Unsolicited Proposal Fund)
- DSS (Source Development Fund)
- Energy R&D (EMR)
- Omnibus (DFO)

	\$ 934,542
	1,000,000
	250,000
	500,000
Total	\$2,684,542

Availability of a cost-effective method of conducting offshore hydrographic surveys, with the potential for gathering more data per ship-day than by conventional methods.

Development of expertise in the design and construction of remote-controlled, semi-submersible vehicles. DOLPHIN has elicited interest from several other poten-



tial users, including the U.S. Navy, which has a number of potential defence uses, and a major oil company for offshore exploration activities.

BIO Science Sector

Hydrography and Oceanography

Eastern Arctic Hydrographic Surveys

Company

Terra Surveys, Sidney, B.C.

Description of Item

Seafloor bathymetry surveys

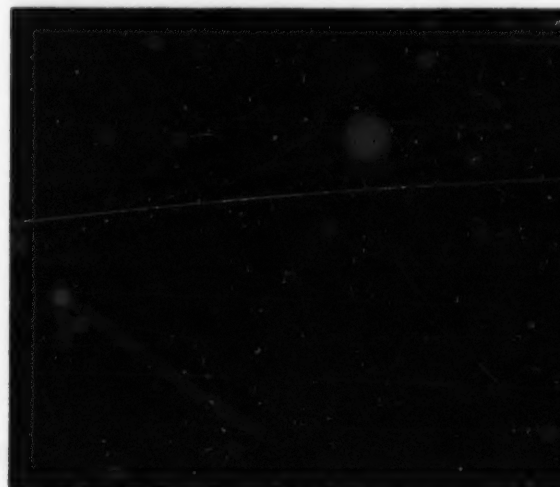
Technology Transferred

Surveying expertise

History of Events

In 1983, it was learned that Borealis Exploration Ltd. of Calgary planned to ship iron ore from its site on Melville Peninsula by 1986/87. However, existing charts were unsuitable for vessel traffic. Because of insufficient in-house capability to undertake all required hydrographic surveys, it was decided to contract out this work. A contract was let in 1984 to Terra Surveys for a hydrographic survey on which to

base the new charts that would meet the needs of shipping. The surveys, of Foxe Basin and Roche Bay, were undertaken in 1984 and 1985.



Value of Support

From BIO:

- portion of a person-year plus travel expenses, to cover the provision of expertise and on-site monitoring
- value of contract

\$ 20,000
\$ 2,300,000
Total \$2,320,000

From external sources:

Nil

Benefits to BIO

BIO received sufficient data to produce new nautical charts that will enable safe vessel transits in this region.

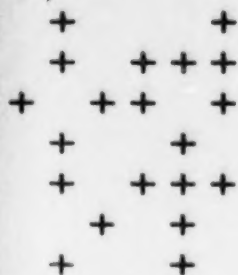
Benefits to the Company

It gained further expertise in surveying to CHS standards and acquired additional

experience in working in the harsh conditions of Canada's north. This will enable the firm to better compete for future contracts in Canada and elsewhere.

BIO Science Sector

Hydrography



Technology Transferred

Methods of, and standards for, latticing navigational charts.

History of Events

Loran-C has been adopted by the Canadian Coast Guard as the prime radio aid to navigation in coastal waters. In 1984 coverage was expanded on the east

coast by the introduction of a new transmitter at Fox Harbour, Labrador. For mariners to make full use of this aid it was necessary that Loran-C lines-of-position be incorporated on all existing charts. Because of the limited number of in-house cartographic staff it was decided to contract out the drafting phase of this project to industry. The work was undertaken in 1984 and 1985.

Value of Support

From BIO:

• drafting materials, consultation, quality control	\$35,000
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From external sources:

• DFO (Loran-C Funds)	\$70,768
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Benefits to BIO

Availability of latticed charts in a timely manner.

BIO Science Sector

Hydrography

Benefits to the Company

Expertise that will enable it to bid on subsequent DFO and other contracts.

Loran-C Lattice Drawing

Company

Wycove Systems Ltd., Dartmouth, N.S.

Description of Item

Computer program to incorporate Loran-C lattice lines on existing navigation charts.

Technology Transferred

Basic BIO computer program to draw Loran-C lattices.

History of Events

In the early 1980s, BIO developed a computer program to prepare rough planning

lattices for Loran-C; i.e., to draw the hyperbolic lattice lines on existing navigation charts. The program included a "warping" ability to account for land-path transmissions. It soon became apparent, however, that the program should be refined to make it easier for a variety of users to operate. It was decided to have this done by private industry. A contract was awarded to Wycove in 1983 to develop the BIO approach into an efficient lattice-drawing program useable on most types of computer, and to undertake some of the actual drawing work.

Value of Support

From BIO:

• contract	\$24,000
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From external sources:

NII

Benefits to BIO

User-friendly program, transportable to most types of computer.

Benefits to the Company

Experience in this specialized field, as a result of which it was able to bid on a

large lattice-drawing contract for the Saudi Arabian Loran chain.

BIO Science Sector

Hydrography

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Computer Model of Grand Banks Ecosystem

Company

ASA Consulting Ltd., Dartmouth, N.S.

Description of Item

Development and preliminary design of a computer model of the Grand Banks ecosystem.

Technology Transferred

Computer modelling expertise.

History of Events

In 1983, the Marine Ecology Laboratory (MEL) at BIO was awarded an OERD con-

tract to develop an ecosystem model of the Grand Banks for the purpose of estimating the potential risk associated with petroleum development. The approach adopted by MEL was to hold a workshop fairly early in the project (i.e., summer 1984). A preliminary working model of the ecosystem was required for this event. Because there were overall time constraints on MEL, and following the usual practice of contracting-out significant amounts of OERD-funded work, it was decided to let a contract to ASA to develop this model.

Value of Support

From BIO:

• contract	\$ 29,814
• advice and consultation	25,000
Total	\$54,814

From external sources:

Nil

Benefits to BIO

Since there were time constraints, the development of the model by ASA enabled BIO staff to concentrate on other aspects of the project, such as the installation of the computer.

Benefits to the Company

It gained expertise in ecosystem modelling, which will enable it to offer a broader range of software. Specifically the company learned about the process of developing a complete ecosystem model and was introduced to the methodology

of size-structure modelling; it also learned about the design of transport submodels for ecosystem models, and how these are interfaced with biological subroutines.

On the basis of the work done on transport submodelling, the firm has been able to win contract work with the Atlantic Oceanographic Laboratory and others on physical oceanographic aspects of the Grand Banks system.

BIO Science Sector

Biological Science

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Electric Rock Core Drill

Company

NORDCO Ltd., St. John's, Nfld.

Description of Item

A remote-controlled and powered hard rock sampling tool capable of operating from non-moored vessels in up to 1000 m of water. The drill penetrates the seafloor up to 6 m and returns cores suitable for geological studies.

Technology Transferred

Plans of prototype equipment developed by BIO; ongoing support and advice.

History of Events

In 1979, NORDCO was advised that the BIO prototype drill was available for licensing. NORDCO applied to CPDL and was awarded non-exclusive rights to drill construction and operations "know-how." The company has manufactured the item since 1980, selling two units (at \$75,000 each) and is currently negotiating a third sale.

Value of Support

From BIO:

• staff time and associated costs	\$8,500
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From external sources:

Nil

Benefits to BIO

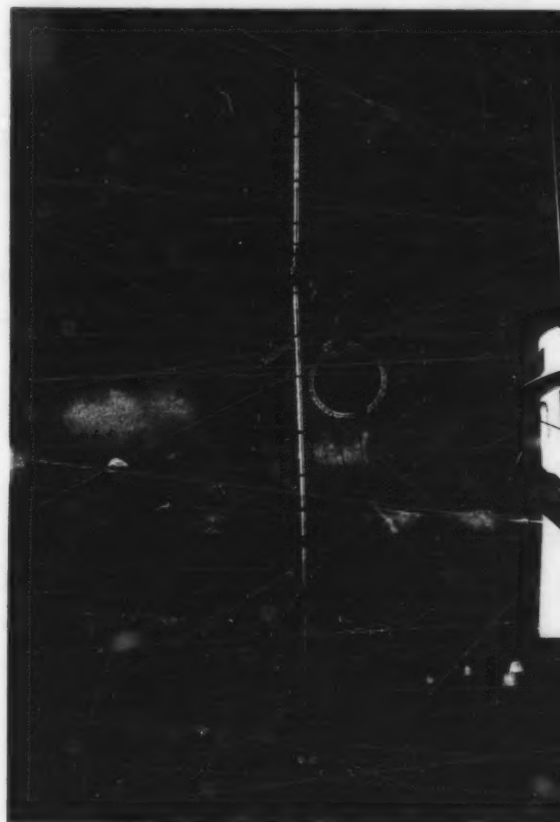
A private sector source is now available to provide parts and service, and also to support BIO's Atlantic Geoscience Centre programs involving drilling operations.

Benefits to the Company

It obtained expertise in the field and has a viable product.

BIO Science Sector

Oceanography



"MINISAL" Portable Salinometer

Company

AGE Instruments Ltd., Smiths Falls, Ont.

Description of Item

Portable salinometer that is direct-reading and equal in accuracy to laboratory instruments over the range 2-42 Practical Salinity Units.

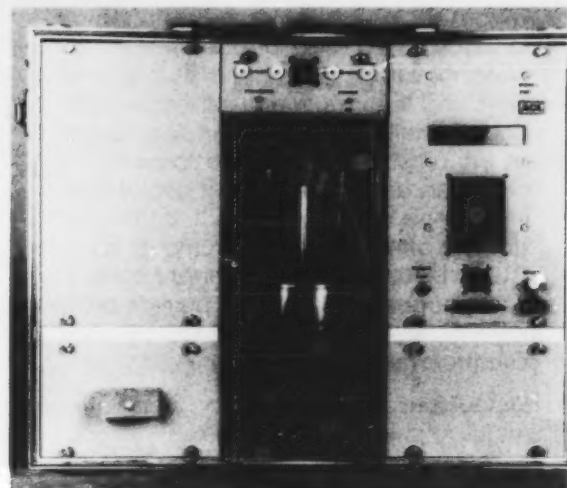
Technology Transferred

Salinometer expertise.

History of Events

Laboratory salinometers are bulky and not easy to use on small vessels. In 1984, two contracts were let to AGE to develop a small, portable instrument. The first prototype instrument was delivered for evaluation in January 1985; similar instruments were subsequently delivered to DFO Newfoundland Region and IOS. An exten-

sive period of evaluation and refinement followed. The instrument is now considered to be in approximately its final form.



Value of Support

From BIO:

- contract for one of the three prototype instruments
- Standards Lab. staff time and associated costs

\$ 6,000
30,000
Total \$36,000

From external sources:

- DFO Newfoundland and IOS (for their instruments)
- DSS Source Development Fund

\$ 12,000
45,000
Total \$57,000

Benefits to BIO

It gained experience with, and acquired, a portable salinometer. Additional applications have been opened up by the very small sample requirements of the new instrument.

The association with BIO has aided the acceptance of the instrument by the international community.

Benefits to the Company

The product has generated widespread interest and a number of units have been sold. Export sales to date are from 12 to 15 times the value of the original investment from the Source Development Fund.

BIO Science Sector

Oceanography

Chemical Extraction Techniques

Company

Seastar instruments Ltd., Sidney, B.C. and
Dartmouth, N.S.

Description of Item

Techniques for the extraction of chemical compounds, elements, and radionuclides from seawater for use in conjunction with a remote pumping system.

Technology Transferred

Various techniques for the extraction and pre-concentration from seawater of organochlorine compounds, trace metals, and certain radionuclides.

Value of Support

From BIO:

- | | |
|---|-----------|
| • staff time and associated laboratory operations | \$ 60,000 |
|---|-----------|

From external sources:

- | | |
|-------------------------------------|-----------|
| • Environmental Contaminants Fund | \$ 40,000 |
| • Ocean Industry Development Office | 63,200 |

Total \$103,200

Benefits to BIO

Follow-up development of research-derived technologies through use of external resources; enhanced capability of contractors for future BIO contracts.

has provided marketing advantages to the company, especially with respect to overseas sales.

Benefits to the Company

Ability to market not only the pumping system as a stand-alone device, but also associated analytical support that provides a complete monitoring service. This

BIO Science Sector

Oceanography

Short-Term Iceberg Prediction Model

Company

ASA Consulting Ltd., Dartmouth, N.S.

Description of Item

Computer model that utilizes the past behaviour of icebergs in a region to

establish the statistical properties, together with forecast tidal currents and winds, to predict the path of an iceberg relative to an oil rig and provide confidence limits for the prediction.

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Technology Transferred

Iceberg-track prediction model; ongoing support and advice.

History of Events

In 1983/84, a contract was let to Dr. C.J. Garrett, Dalhousie University, Halifax, utilizing OERD funds, to investigate the statistics of iceberg movements on the Newfoundland and Labrador shelves and to develop a statistical approach for predict-

ing the track of an iceberg. A model was developed under this contract, and during the following year Dr. Garrett continued to refine it using his own research funds. In 1985, the Environmental Studies Revolving Fund (ESRF) supported, via a contract, the transfer of this technology to industry, specifically ASA Consulting. Later that year ASA produced a microcomputer-based system for this model; this has been tested against other models and found to be the best predictive model available as of 1986.

Value of Support

From BIO:

• contract management and associated activities	\$ 5,000
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From external sources:

• Energy R&D (EMR) (contract with Dalhousie Univ)	\$ 20,000
• ESRF Funding	50,000
• Dalhousie Univ (value of in-house support)	50,000
Total	\$120,000

Benefits to BIO

A reference against which to assess in-house iceberg research.

Benefits to the Company

Possible contracts to train offshore operators in the use of the model; possible extension of the approach to oil-spill trajectory modelling and to search-and-rescue operations for persons lost at sea.

BIO Science Sector

Oceanography

Tidal Modelling

Company

Discovery Consultants Ltd., Wolfville, N.S.

Description of Item

Prediction of changes in the tidal regime resulting from engineering projects; e.g., tidal power barrier.

Technology Transferred

BIO two-dimensional barotropic tidal numerical model.

History of Events

In 1985, the Nova Scotia Tidal Power Corporation requested BIO to make predictions of the changes in the tidal regime due to several additional tidal power scenarios. Predictions had been previously undertaken in respect of other scenarios. Since Discovery Consultants were already familiar with the BIO model, it was decided to encourage them to become fully conversant so that jobs such as the above could be referred to them. This was done, and the company undertook the above work on contract for the Nova Scotia Tidal Power Corporation.

• advice and consultation	\$2,000
From external sources:	Nil

Benefits to the Company

It has acquired recognized expertise in the field and, as a result, has gained new contract work.

Oceanography

Company

Brooke Ocean Technology, Halifax, N.S.

History of Events

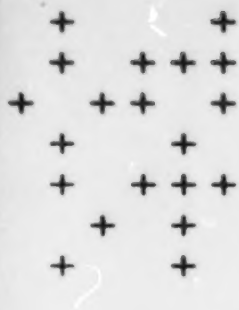
In 1982, BIO identified several problem areas associated with mooring operations. Industry was canvassed for interest and, as a result, Brooke Ocean Technology applied for UP funding to investigate mooring recovery methods. In 1983/84 the company built and tested alternate systems. In 1984/85, it received a contract to build and test a production prototype mooring recovery system.

Advice and expertise pertaining to the recovery of moorings.

From BIO:	
• contribution to UP	\$ 30,000
• other contracts	48,000
• ship time	142,000
• staff time	68,000
Total	\$288,000
From external sources:	
• DSS UP	\$ 90,000

Benefits to the Company

It obtained experience in the production of equipment for operation in the ocean environment. When perfected, the mooring



recovery sweep device should have commercial potential. In addition, other applications such as the photo-mosaic system should enhance sales prospects.

BIO Science Sector

Oceanography

Aluminum Offshore Hydrographic Survey Launch

Company

Crockett & McConnell Inc.,
Bridgewater, N.S.

Description of Item

New 31-foot launch for offshore hydrographic surveys.

Technology Transferred

Advice on the operational requirements and technical aspects of the design and construction of the launch.

Value of Support

From BIO:

• staff time and associated costs

\$10,000

From external sources:

NII

Benefits to BIO

A modern launch ("Osprey") with improved performance in the logging of hydrographic data at high speeds under offshore conditions (expected to double the bathymetric data collecting capability of existing 31-foot launches now in service at BIO).

Benefits to the Company

A competitive product that has the potential for being marketed worldwide to the oceanographic/hydrographic community: company market surveys indicate a potential sale of up to 20 units (approx. \$200,000 each) over the next five years.

BIO Science Sector

Oceanography

Optical Zooplankton Counter

Company

AGE Instruments Ltd., Smiths Falls, Ont.

Description of Item

Instrument to count and size zooplankton in the marine environment and simultaneously measure their food source by means

of light attendance; both in-situ towed and laboratory versions are involved.

Technology Transferred

Design technology for instrument; advice and consultation.

History of Events

The instrument was developed and patented through BIO; the technology was then transferred to AGE in 1985. The company has secured a licence to manufac-

ture from Canadian Patents & Developments Ltd. In 1986 AGE obtained a UP grant to further develop the device, including its application in turbid waters.

Value of Support

From BIO:

• staff time	\$ 5,000
• ship time	200
• computer time	1,000
Total	\$ 6,200

From external sources:

• DFO Quebec (purchase of instrument as part of UP)	\$ 40,000
• DSS (1986/87 contribution to UP)	100,000
• Energy R&D (EMR) (1986/87 contribution to UP)	15,000
Total	\$155,000

Benefits to BIO

The availability of a commercial laboratory unit capable of surveying offshore waters and a commercial laboratory unit capable of analysing large volumes of preserved samples (thereby reducing costly microscopic analysis and counting).

Benefits to the Company

It is commencing commercial production of the instrument. Two units have already been ordered. After a few more years of marketing and product development by the company, it is expected that there will be a potential market for several hundred units (approx. price \$35,000 each).

BIO Science Sector

Oceanography

Provision of Library Services to Local Industry

Company

Various small marine-science and ocean-engineering companies and consultants.

Description of Item

Provision of services such as: free borrowing privileges for circulating materials; use of photocopiers and microform reader/printers; interlibrary loans for materials not held in BIO or other local libraries; and computerized literature searches on topics related to the marine sciences. (Note: charges are levied for the latter three services).

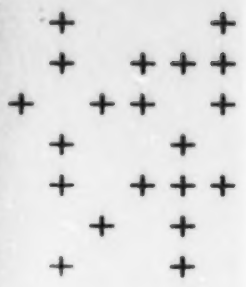
Technology Transferred

Marine science and ocean engineering information contained in published sources held in BIO's national collection in the marine sciences, elsewhere within the DFO library network (through access to the WAVES database), and around the world (through access to major international databases).

History of Events

The number of "registered" companies using the service has grown from 13 in 1980 to 64 in 1986.

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Value of Support

From BIO:

• PY costs per year

\$8,000

From external sources:

NII

Benefits to BIO

Companies on contract to BIO have access to specialized library facilities to aid them in their work.

Benefits to the Companies

Inexpensive, convenient access to information required during the course of their work that would otherwise be available to them only at a considerable cost (if they were able to develop their own in-house library), less conveniently (if they were forced to go to libraries without an in-depth collection of marine-science

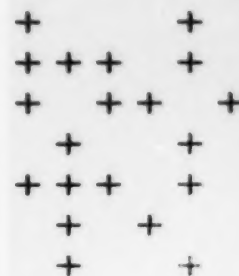
materials), or not at all. In 1981 a local consulting company closed down its in-house library because of cost, which was a minimum of \$25,000 per year, even though the library depended very heavily on other local libraries (including BIO) for information.

BIO Science Sector

Oceanography

*Mr. Nicholls is Head, Marine Assessment and Liaison Division at the Bedford Institute of Oceanography, DFO, Dartmouth, Nova Scotia, and Mr. Seibert is Program Analyst and Projects Coordinator at that Institute.

Appendix



List of Transferred Technologies

<i>Name of Technology</i>	<i>Case Number</i>	<i>Page Number</i>
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